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E-Dustbin

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Abstract

A major problem with our present society is the solid waste management, as it disturbs both the human health and affects the environment. Monitoring of those wastes is one of the major problems of the present. The traditional method of solving this issue is by making use of huge trash cans in public places and utilizing the role of human scavengers, which is time consuming in nature. This paper proposes an advanced method in which waste management is automated. This project aims at making use of a wheeled bot, which detects the wastes and collects in the trash can provided with the bot, with the help of a digital camera, in a similar way how human scavengers collect wastes and separates the useful items if any mixed with the wastes. The bot also segregates the useful items from the wastes with the aid of IoT. The penultimate aim in making this project is to promote smart city concept and to reduce the diseases that spread due to accumulation of wastes in public places and to improve sanitation.

Keywords: *Arduino AT mega 2560, Dual full bridge L298 motor driver, servo motor, servo arm, servo gripper, digital image processing, IoT, waste management and segregation*

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INTRODUCTION

The trend of making the manually controlled things automatic has become a common practice these days. The process of making the things automatic is being exploited in almost all the major fields of life. Introducing automation in every field can reduce the burden on the humans and comparably reduces the cost and time, as when compared to man-made processes. There is an immediate need for waste management, as nowadays people don't find time to do so. The proper waste management system is must for the hygienic society in general and for world as a whole. Solid waste which is one of the sources and causes of environmental pollution has been defined under Resource Conservation and Recovery Act as any solid, semi-solid liquid or contained gaseous materials discarded from industrial, commercial, mining or agricultural operations and from community activities [1]. Solid waste also includes garbage, construction debris, commercial refuse, and sludge from water or waste treatment plants or air pollution, control facilities and other discarded materials [2]. In order to protect the human health and the environment from the potential hazards of delayed waste disposal and environmental pollution a systematically supervised and controlled handling of these wastes is must.

The type of wastes which constitute environmental pollution and which this work emphasizes on is domestic refuse consisting of degradable food wastes, leaves, dead animals and non-degradable ones such as plastics, bottles, nylon, medical and hospital wastes, generated in households, hospitals, industries and commercial centres. The various wastes dumped to the environment necessitates to the development of new innovations to control them. Decision support systems (DSS) are among the most promising approaches to confront such situations. Disposing of wastes in public areas causes breeding of mosquitoes and foul smelling, which further leads to many health problems, including COPD (Chronic Obstructive Pulmonary Disease). Almost 90% of this occurs in low and middle income countries, which took away the lives of around 3 million in the year 2005.

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EXISTING TECHNOLOGY

This work, automated waste management system [3] presented here certainly provides a novel approach in handling and disposing off the day to day solid wastes in an efficient and easy way. The system makes use of radio frequency (RF) tags and web support. The system automates the solid waste monitoring process and it manages the overall collection processes.

Smart dustbin [4] is another project, which indicates directly that the dustbin is filled to a certain level by the garbage and cleaning or emptying them is a matter of immediate concern. This prevents the lumping of garbage in the roadside dustbin which ends up giving a foul smell and causes illness to the people. The design of the smart dustbin includes a single directional cylinder and an Arduino Uno. The circuit to power up the mechanical devices is also assembled to obtain the desired simulation. Another electro-mechanical based dustbin [5] was created with the help of electrical and mechanical actuators, which is used to collect the garbage and control atmospheric pollution by trapping the foul smell inside the garbage can.

DEMERITS OF PREVAILING TECHNOLOGY

The existing technologies include either detecting of over flowing binsand trash cans and crushing them (4) or moving of bins using RFID transmitters [3]. But they failed to detect and identify the wastes that are lying on the ground and are not capable of picking and collecting the wastes. All the prevailing technologies lacked in identifying the wastes and they were stagnant i.e, they were fixed in one place and they simply collect the wastes.

PROPOSED SYSTEM

The proposed system makes use of a wheeled bot which moves from one place to another. It utilizes of a servo arm which has the capability of picking the wastes from the ground and dropping them onto the bin provided with the bot. the objects are then categorized and placed in separate bins, as wastes are kept in trash cans and any useful items if spotted are kept separately in a basket placed on the back of the bot.

COMPONENTS AND ITS PROPERTIES

DC MOTOR

The DC motor shown in the Figure 1 is used to drive the cross slide to provide linear movement. This motor can deliver high output torque as it consists of worm and worm wheel arrangement fitted into its shaft and is housed perfectly. Rotation is possible in both clockwise and also in counter clockwise directions.

Fig. 1: *DC Motor.*

DC MOTOR SPECIFICATIONS

The electric power supply necessary to run the DC motor is obtained from an H-Bridge motor driver board and a 12V Battery. The technical specifications are mentioned in the Table 1.

Table 1: *Technical Specification of 12V DC Motor.*

Voltage	12V DC
No Load Current	300 mA
Load Current	1.3A
RPM	100 at 12V
Stall torque	10 Kg-cm at stall current of 1.3 Amp
Shaft diameter	6 mm
Shaft length	22 mm
Gear assembly	Spur
Brush type	Carbon
Motor weight	143 gms

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DC MOTOR DRIVER

The motor drivers are used for quiet and smooth operation of the motor. The dual full bridge L298 motor driver shown in Figure 2 is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors. There are two enable inputs to enable or disable the device, irrespective to the input signals. An additional supply input is provided so that the logic works at a lower voltage and high precision current feedback and this is absolutely silent when the motor is stopped or turning slowly. It virtually eliminates stopped-motor heating regardless of power supply voltage. The Table 2 shows the technical specifications of the motor driver.

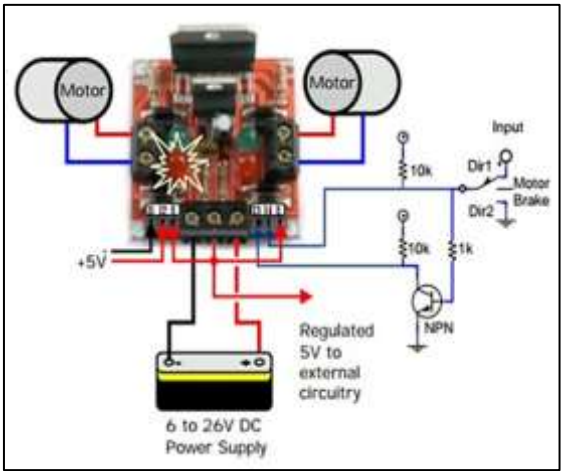

Fig. 2: *Motor Driver.*

Table 2: *Technical Specification of Motor Driver.*

Input Voltage	6 to 26 V DC
Current rating	Up to 4A max
Driving capacity	Can drive two motors at a time

SERVO ARM

A servo arm is a piece of equipment that is programmed to manipulate objects and to function similar to the human arm. The robot arm is probably the most mathematically complex robot that could ever built. The robotic arm is used in several aspects of manufacturing. This piece of equipment is used to perform different functions that are too dangerous, too difficult or too tedious for a human to do. A servo arm consists of two servo motors equipped with gear reduction unit for movement and links. The possible directions that a servo arm can rotate are about the X, Y and Z axes. The arm can make both translatory and rotary motions. A servo arm is as shown in the Figure 3.

Fig. 3: *Servo Arm.*

SERVO GRIPPER

A servo gripper, shown in the Figure 4 is an artificial module which resembles the human fist. A maximum current of 0.45 Amps will be drawn at the maximum and provides a grip force of 50 N. it also utilizes the servo motor with gear reduction unit. It acts in a way similar to a solenoid valve, which closes and opens when supply is altered. In order to provide a highly reproducible grip force the supply voltage should be close to the nominal input voltage of 12/24 Volts DC. As spur gear mechanism is used inside a Servo gripper, it retains the current position even if a power loss occurs and hence the object will be held tight.

Fig. 4: *Servo Gripper.*

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ARDUINO BOARD

Arduino ATMEGA is an open source microcontroller board based on the AT mega 2560, shown in the Figure 5 is a 32-bit AVR microcontroller with complementary components that facilitate programming and incorporation into other circuits. The board is easy to configure, as it is an open source platform and a freeware licensed software.This makes using an Arduino more straightforward by allowing the use of an ordinary computer as the programmer. Currently, opt boot boot loader is the default boot loader installed on Arduino ATMEGA.

SPECIFICATIONS

The technical specifications of the Arduino AT mega and other related specifications are described on the Table 3.

DIGITAL IMAGE PROCESSING

Object tracking is significant discipline aiming to define techniques and systems for processing images from cameras placed in a specific environment. The need for high power computers, the availability of high quality and inexpensive cameras, and the increasing need for automated image analysis has generated a great deal of interest in object tracking algorithms. Tracking an object in image has a variety of real world applications; these include autonomous aerial reconnaissance, remote surveillance, and advanced real time collision avoidance systems. There are three key steps in real time camera analysis viz. detection of interesting moving objects, tracking of such objects from frame to frame, enhancement and analysis of frames to recognize their behavior as shown in Figure 6.

Table 3: *Technical Specifications of Arduino Mega 2560.*

Microcontroller	ATmega2560
Operating Voltage	5 V
Input Voltage (recommended)	7–12 V
Input Voltage (limits)	6–20 V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	16 mA
DC Current for 3.3 V Pin	50 mA
Flash Memory	256 KB (ATmega2560) of which 8 KB used by boot loader
SRAM	8 KB (ATmega2560)
EEPROM	4 KB (ATmega2560)
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

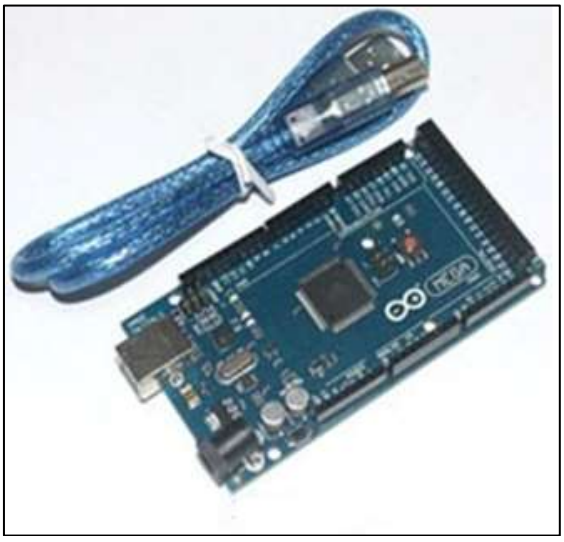

Fig. 5: *Arduino Motor.*

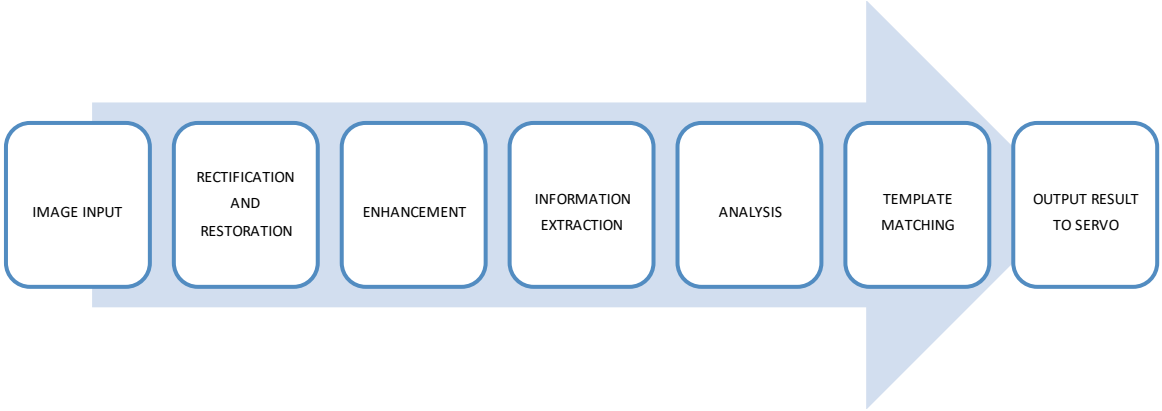

Fig. 6: *Stages in Digital Image Processing*

RECTIFICATION

Rectification is a process of correcting an image geometrically. Image enhancement techniques improve the quality of an image. These techniques are most useful because man images when examined on a color display give inadequate information for image interpretation. Object-Based Image Analysis (OBIA) employs two main processes, segmentation and classification. Traditional image segmentation is on a per-pixel basis. Template matching is a technique used in classifying an object by comparing portions of images with another image. It is the simplest and widely used for detecting targets in image information.

CMOS CAMERA

The OV7660 shown in the Figure 7 is a low resolution, low voltage CMOS image sensor that provides the full functionality of a single-chip VGA camera. It is controlled through the Serial Camera Control Bus (SCCB) interface. It operates at a shutter speed of 30FPS. The pin configuration is as shown in the Table 4.

ESP-8266 WiFi TRANS-RECEIVER MODULE

The internet of things (IoT) is the internetworking of physical devices, vehicles, buildings and other items like embedded with sensors, actuators, electronics, software and network connectivity that enable these objects to collect and exchange data.

Fig. 7: *CMOS Camera.*

The ESP8266 WiFi Module, as shown in Figure 8. The module can be used to send and receive data between the Arduino board and the cloud.Each ESP8266 module comes pre-programmed with an AT command set firmware.The ESP8266 module is an extremely cost effective board.It has a powerful on-board processor and built in memory, that allows it to be integrated with sensors and other application specific devices through its 3 GPIOs. The TX and RX serial communication pins can be used to interface it with the Arduino board for transfer of data.

Table 4: *Pin Configuration of CMOS Camera.*

Pin NO	PIN NAME	PIN TYPE	DESCRIPTION
1	VCC	POWER	3.3v power supply
2	GND	GROUND	power ground
3	SCL	INPUT	two wire serial interface clock
4	SDATA	BI-DIRECTIONAL	two wire Seriel interface data i/o
5	VSYNC	OUTPUT	active high: frame valid; indicates active frame
6	HREF	OUTPUT	active high: line/data valid; indicates active pixels
7	PCLK	OUTPUT	pixel clock output from sensor
8	XCLK	INPUT	master clock into sensor
9	DOUT9	OUTPUT	pixel data output 9 (msb)
10	DOUT8	OUTPUT	pixel data output 8
11	DOUT7	OUTPUT	pixel data output 7
12	DOUT6	OUTPUT	pixel output 6
13	DOUT5	OUTPUT	pixel output 5
14	DOUT4	OUTPUT	pixel output 4
15	DOUT3	OUTPUT	pixel output 3
16	DOUT2	OUTPUT	pixel output 2(lsb)
17	PWDN	INPUT	power down
18	RSV	NC	Reserved
19	RSV	NC	Reserved
20	RSV	NC	Reserved

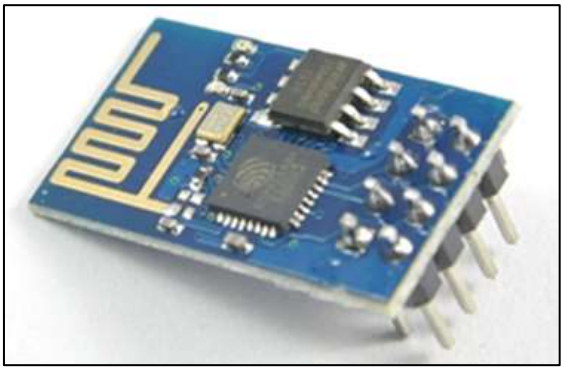

Fig. 8: *ESP8266 WiFi Module.*

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WORKING

In these recent years, soil pollution due to deposition of wastes has become a major threat and is the reason behind many problems. Hence, it is a mandatory to collect the waste which causes pollution and to ensure sanitation in especially public places, where population rates are comparably high. The robot is controlled with the help of an Arduino Mega-2560 microcontroller. As soon as the bot finds any wastes on the floor, with the help of digital image processing technology, the bot moves to the place and picks the wastes with the aid of the two axis servo arm and servo gripper, attached at the front part of the bot and drops it onto the trash can, which the bot bears on its back. In this project, Digital Image Processing plays a vital role, scanning each and every item on the floor surface with the help of a CMOS camera. The reason digital image processing has been used is that it has the ability to categorize the objects with the help of an internet connectivity, which has been made possible with the help of IoT technology and thus wastes can be easily identified and picked. If any useful items found on the floor, it is picked and kept separately on the basket provided with the bot. the boot also has a advantage that if any human interrupts its path, it automatically changes its path and makes a new path and starts to clean the environment, which has been made possible with the aid of implementing digital image processing to this system. The two-axis servo arm acts similar to a human arm in picking the wastes. Servo gripper holds the wastes. The servo grippers has a unique advantage that, even if there is a rupture of power, it holds particle with the same strength as it has a high torque to speed ratio. The bot can move from one place to other with the aid of a pair of DC motors. This stand-alone wheeled bot has the capability to segregate wastes like a human scavenger picking wastes and separating useful particles from them. This system has its unique advantages that there is no need for human scavenger to pick hazardous wastes and wastes which are the results of spreading of various diseases and hence it indirectly improves sanitation to the place.

MERITS AND DEMERITS IN IMPLEMENTING THE VEHICLE AUTOMATION TECHNOLOGY

A. MERITS

- Reliable and cost efficient.
- The automated waste collecting technology provides easy way to control wastes deposition in areas where there is a dense population.
- High levels of safety regarding the pollution abatement are ensured.
- Collection of wastes in a comparably easier and safer way.
- Promotes greener solution and is a part of smart city concept.
- Easy way of providing sanitation in public places.

B. DEMERITS

- Accuracy in finding the wastes depends mainly on signal strength.
- The sensor may occasionally fail and hence faulty signals could be sent to the microcontroller board.
- As a digital camera is used, sensing of objects is directly proportional to the availability of light intensity.

CONCLUSION

Thus by implementing this technology, we can collect the wastes easily and soil pollution levels due to deposition of wastes onto the ground can be reduced. It has the immense potential to detect the wastes at a rate comparably faster than any other, as it is equipped with the latest and advanced Image Processing technology. Since it is an atomized technology, it doesn't require any manpower to work and the accuracy rates are high.

Our present scenario is a situation where global warming is occurring very rapidly due to industrialization and depositing wastes on the ground, due to which soil pollution rates are raised drastically over the recent years and as a result the ozone layer, which is a protective shield from the harmful ultra-violet ray has been depleted. Hence, it is mandatory to reduce the soil pollution due to wastes deposition which also causes global warming. The main motive of this project is to detect and collect the wastes on the ground and to maintain sanitation at a rate faster than any other.

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